Zodiac 14

enough to sell to, one **in a** hundred that should and would have them if rightly known and understood, for real value and usefulness. When all are sold out, cannot be duplicated, for less than $250 each, as the expensive tools, that turned them out so cheap, have all been destroyed, so said the one that made them, that "no more should ever be made," so buy quick, "now is the accepted time."

The intelligent Teacher who will give a few hours study to the illustrations with the Lunatellus and Heliotellus will soon be well prepared to give Celestial *Object Lessons* of Havenly beauty; they move so truly to nature, it will never be necessary to shock the pupils acute sense of truthfulness by denying what is once told, (as with the Orrery, we do not mean, the Earth moves in the horizon, and revolves from North to South, or South to North, and points near the Zenith for the North Pole, but we do mean, and) by these show, that the Earth moves in the Ecliptic, when set so the Axis points North and South, revolves from West to East. Never getting as far out of the true line, as the Orrery never comes into the true line. These as true to nature, as the others to the wrong, coming much nearer to the real, than any other instruments made, a careful examination will make their intrensic value apparent to all. A very great improvement has been discovered that *doubles their lasting value* which will be added to all sold by HENRY WHITALL, Prof. of Astronomy, Park Institute, 859 Sixth Ave., New York. Permanent address, 512 Arch St., Philadelphia, Pa., all letters remailed to me as I move.

PREFACE.

We have six different Planispheres, which took the first *Medal* and *Diploma* at the grand Fair of the American Institute, 1869. No. 1 was made in 1856, with the Constellations very beautifully painted like the Celestial Globe, and is sold for $3. No. 2 was made in 1862, to look like the sky, black ground, stars white: sold for $3. Both are now very much improved, and make a complete set: sent by mail on the receipt of $6. No. 3 includes Nos. 1 and 2 in one; ground black, stars, Constellations, and names white. Got up like a book, Planisphere on one large cover, the Rules on the other cover: sold or sent by mail, $5. No. 4, stars and names black, Constellations colored to their boundaries; got up for the new American Constellation, formed out of many others, in honor of U. S. Grant, President, by J. T. Sweet, of Telescope, Fifth Avenue and Twenty-Third Street, N.Y.: sold or sent by mail on receipt of $3. No. 5 is a small one, being an exact copy of a large one, prepared for the purpose of being put on the inside of the cover of all Astronomies; for size see title page: sold or sent by mail on receipt of 75 cents. No. 6 is very nicely photographed on glass, in a mahogany frame, with brass cog-wheels, set at any minute as explained, for a stereoptican or magic lantern: Stars and Constellations like the Celestial Globe, sold for $6. No. 7 same as No 6, only more natural showing the stars like the sky: sold for $6. The two make a set: sent by Express for $12, C.O.D., and may be put on a screen twenty or fifty feet in size, and be black, so that all the light will shine through the darkness, and show the stars as lights very naturally, so much like the sky that the large stars may be learned in an hour or so.

Most every Teacher knows more or less of Astronomy, and often get to talking about some Constellation or Planet, or wonder what is that star by the moon, all such will find the Planisphere to the sky, what a Directory is to the City, for any minute in the day found on the movable horizon, can be brought to any day found on the Planisphere. Then in the horizon will be seen the star just so far above the horizon, as then seen with the name along side it. Should it be a planet, we want it will not be found on the Planisphere, but by rule, 9 on page 7, and the Almanac, we can locate it.

Many attend a lecture on Astronomy, and probably carried away in rapture and going out look on the sky, but cannot tell which is the one spoken of, to such I will say take the Planisphere, for it is to the sky what a map is to the study of Geography.

I received two lessons that made the most lasting impressions upon my mind. First by my dear aunt Jane, who showed me many of the stars and their interesting beauties, when I asked, what bright star is that? not being answered, raised in me a desire if I ever got big, I would know them all. When I graduated I could calculate an Almanac, but not name a star when I saw it. While teaching at Coletown, N. J., the Hon. John W. Hazleton, after his brilliant speach at our debate, gave me the second lesson, and by far the greatest of my life. Calling each star by name with a familiarity that struck me with pleasure and delight, I asked him where he got his knowledge from, he told me from Burritt's Geography of the Heavens; as soon as it was in my power, I owned that treasure, being a teacher and trying to overcome the difficulties met with, brought out Maps of the whole Heavens, as we see it. 21 years improvement brought me to my moveable Planisphere, with them I have solved many new, hard and difficult problems, I never knew before, one the Eaquation of time. Burritt, page 201. "It appears that from Ariese to Cancer, the Sun in the ecliptic comes to the meridian *before* the equinoctial Sun." With the Figure by it I would study until my head would ache, at times for 15 years, and neither understood it nor met with any one to tell me. I solved the trouble by the Planisphere thus: Bring the Meridian to 30° R. A. on the equinoctial, clock time, I see 30° on the ecliptic Sun time appears slow going from the vernal equinox to the summer solstice as the Sun moves through April, May and June, see his place where the day of the month is, it looks as though it had not yet arrived at the Meridian is the point I could not understand until I saw the whole on the face of the Planisphere, showing what I was wanting to see, the east whese the sun rises, then coming to the Meridian, showing the Sun past the Meridian towards the west, see rule 19, page 8.

THE TWELVE SIGNS AND THE CONSTELLATIONS.

TWELVE SIGNS OF THE ZODIAC.

☞ The names of the Constellations and Stars are accented on each Planisphere.

A'RI-ES (*the Ram*) was 2155¾ years passing over the vernal equinox. While there, it was correct to say first point A'ri-es; as it has gone away, never to return, why not say *first point Pis'ces?* but Astrology demands, Astronomy consents, one sign in the rear.

1. ♈ PIS'CES (*the Fishes*), at the vernal equinox, where the ecliptic and equator meet on the *first meridian*. See painted Planisphere. The Fishes tied together by a flowing ribbon, making an angle at (*α*) alpha. The stars are all small. On the black Planisphere, see *α*, *o*, *π*, *η*, *ρ* ribbon running north; *α*, *ξ*, *ν*, *μ*, *ζ*, *ε* on the ecliptic; *δ*, *d*, *ω* in ribbon running west; *ι*, *λ*, *ϑ*, *χ* in a square like the four corners of a house, *γ* would make the peak or gable end, in the western Fish's eye.

2. ♉ A'RI-ES (*the Ram*). In the horns find *α*, *β*, *γ* of the 2nd, 3rd, and 4th magnitudes, and *δ* in the tail.

3. ♊ TAU'RUS (*the Bull*). In the face find *α*, *ϑ*, *λ*, *δ*, *ε*, forming a triangle like a V or A, and called Hyades; *α* and *ε* the Bull's eyes. Both sides of the triangle extended would meet *β*, *ζ* in the ends of the horns. Pleiades (*Ple-ya-dez*), or seven stars, in the back of the neck, named after the seven daughters of Atlas, *η* Al-cy'o-ne, Merope, Maia, Electra, Tayeta, Sterope, and Celena. Merope married a mortal, so she is dim among her sisters.

I have a telescope, cased and rest or supporter, so small as all to go into my pocket; but it will show me 40 stars more plainly than I can count 6 in the Plei'a-des with my unassisted eye; and which I can afford to sell for $25; or I have one a little larger, that shows me 60 stars in the Plei'a-des; the stars in the Milky Way as thick as the beard stands on my face, and as distinctly separate as after shaving; Mercury, horned like the Moon at six days old; Venus, about the size of the Moon at ten days old; Jupiter's belts and four moons; Saturn's ring and moons, — good enough for any of my classes in Astronomy,— that I will sell for $50.

4. ♋ GEM'I-NI (*the Twins*). In the heads find *α*, *β*; *ε*, *ζ*, *λ* near the knees; *η*, *μ*, *ν*, *γ*, *ξ* near their feet; in three lines nearly parallel, *α*, *ε*, *μ*; and *β*, *δ*, *ζ*, *γ* nearly parallel lines. *λ*, *ξ*.

5. ♌ CAN'CER (*the Crab*). The stars all small, but can be found by the Planisphere. Making a triangle with *γ* and *δ* is *ε*, looking something like a distant comet; but when seen through my $25 telescope, we see stars as thick as bees around the hive. It is called the *Bee Hive.*

6. ♍ LE'O (*the Lion*). In the fore-shoulder, *α* and *η* make the handle of *η*, *γ*, *ζ*, *μ*, *ε*, *λ*, the blade of the *Sickle;* *β*, E, *δ*, *ϑ* make a large parallelogram.

7. ♎ VIR'GO (*the Virgin*). In the sheaf of wheat *α*; *ϑ*, *γ*, *η* on the left side and shoulder; *β*, *ν* in the head; z, *ι* in the lower part of her skirt; *μ*, *ψ*, *λ*, *κ* in and near her feet. Look them out on the painted Planisphere; and then take the black or natural one, to see how they look on the sky.

8. ♏ LI'BRA (*the Scales*). Find *α*, *β*, *γ*, *π*, which make nearly a square.

9. ♐ SCOR'PI-O (*the Scorpion*). *ν*, *β*, *δ*, *π*, *ρ* form the curve, with *σ* the body of a bow-kite, *α*, *τ*, *ε*, *μ*, *ζ*, *η*, *ϑ*, *κ*, *λ*, *υ* the bobs: well worth looking up.

10. ♑ SAG-IT-TA'RI-US (*the Archer*). *ψ*, *σ*, *τ*, *ζ* make the bowl of an inverted dipper; *λ*, *μ* make the handle in the Milky Way: called the *Milk Dipper.*

11. ♒ CAP'RI-COR-NUS (*the Goat*). *α*, *β* in the horn; *γ*, *δ* in the tail.

12. ♓ A-QUA'RI-US (*the Water-Bearer*). *η*, *ζ*, *γ*, *π* in the urn make a Y.

The Ecliptic is divided into 12 signs: count 30° in each. Bring any minute we want to look at the sky to the day of the month. Inside the horizon see six of them; note their position; and go out and see them just as represented, by holding east towards the east horizon, south towards the south, with all the other points of the compass to correspond, the zenith overhead. Thus can six of the twelve signs be traced out on the clear sky.

THE CONSTELLATIONS.

PEG'A-SUS (*the Winged Horse*). *α*, *β*, *γ*, with *α* Al'phe-ratz, make the *Square* or *Table;* *ζ*, *α*, with *α* in head of AN-DROM'E-DA, *δ*, *β*, *γ* a line of beatiful stars diagonally across the Square; *ε*, *δ*, *π* near the breast; *β*, *μ*, *ν*, called the Girdle; *γ* in left foot; *ν* in right foot; *α*, *γ*, on the first meridian, point out the vernal equinox, about as far below as they are apart.

CAS-SI-O-PE'IA. *α*, *β*, *γ* form a triangle; *γ*, *δ*, *ε* make another,—the two a W; *α*, *β* the feet; *γ*, *κ* the seat; *δ*, *ε* the back of the chair. Turn the horizon all around, being sure to keep the north always down towards the north horizon, the North Pole up, with the eye fixed upon the Chair as it revolves around the North Pole. Seen sometimes right side up, lying down on its back, upside down, feet up, and back down, and thrown down, with the back of the Chair up. Try it, as a beautiful puzzle for a scientific evening's entertainment. At any day outside find the hour and minute it will be in that position.

CE'PHE-US, *king of Ethiopia,* husband to Cassiopeia, father of Andromeda, father-in-law of Perseus, make the *Royal Family.* *α*, *β*, *γ*, *ι* form a large diamond; *δ*, *ε*, *ζ* a little triangle in the crown and Milky Way.

PER'SE-US with *Ca'put Me-du'sa.* *η*, *γ*, *α*, *δ*, *c*, *μ*, *λ* look like a J or skate-runner; *β* is variable, it sometimes gets as small as *ρ* alongside

it, and returns to second magnitude in 3½ hours. Well worth looking up, and watching to see the change.

UR'SA MA'JOR (*the Great Bear*). *α*, *β*, the two hind wheels of the wagon, point towards the Polar Star; *γ*, *δ* the fore wheels; *ε*, *ζ*, *η* the three horses; called the *Dipper, Butcher's Cleaver Ladle, Frying-Pan, Plough, Broad Axe, Bier* and *Three Mourners,*—some call them the *Great Bear,* not taking into consideration the other stars. *α*, *β* are called the *Pointers,* because they point one way toward the North Pole; they point the other way toward the two stars *ν*, *ξ* in the hindermost hind paw; *μ*, *λ* in the foremost hind paw; *κ*, *ι* in the fore paw,—three pairs of stars in a line. *ϑ*, *ψ*, *υ*, h, *o*, curving in fore-leg, shoulder, neck, and head. Find them all, then look them out on the black Planisphere, that looks so natural, like the sky. When all are seen on the sky, and the very *great* space they occupy observed, we will not be disappointed that the word *great* was used, for he occupies a great space on the face of the heavens. It will astonish any one when first they find out how many different positions he is in during the year. By the Planisphere, it may be as easily as it is pleasantly shown. Suppose we wish to look him up on the 4th of July, 9 o'clock; we then bring 9 o'clock on the movable horizon to July 4th on the Planisphere. Ursa Major will be seen half way between the northwest and zenith, running toward the northwest, with his tail up. Running down hill, the handle of the *Dipper* towards the zenith. By the middle of August, he will have made a very great change. Bring 9 o'clock to the 15th of August; see the paws a little above, and nearly parallel to the northwestern horizon. On Christmas night, he will appear reversed. Bring 9 o'clock evening to December 25th, and find the paws not parallel, but nearly perpendicular to the horizon. The Bear not running down, but up, while the handle of the *Dipper* will not be up but down. Bring 9 o'clock evening to the 15th of April, and find his hind paws nearly overhead.

UR'SA MI'NOR (*the Little Bear*). *α* Polaris, or North Pole Star, in the end of the Little Bear's tail, is 1° 22′ 4″ from the Pole (or centre of the rivet) toward Cassiopeia. In the fore-shoulder find *β*, *γ*; near his hind quarter find *ζ*, *η*: the last four make the bowl of the *Little Dipper*; *ε*, *δ*, *α* in the handle make the *Butcher's Little Cleaver, Little Ladle, Little Frying-Pan,* &c. The *Pointers* point out the Pole Star. Between it and the tail of the Great Bear will always be the *Little Dipper.* The Pole Star, *β*, *α*, *γ* beautifully mark out the *first meridian,* the line from which Right Ascension begins. Look them up.

AQUILA, *Ac'we-la* (*the Eagle*), flying across the Milky Way; *α*, *β*, *γ* in the neck, in a row. No other three such stars. *ε*, *ζ* in the tail; *μ*, *δ* in the wing.

TAU-RUS PO-NI-A'TOW-SKI. *k*, *n*, *o*, *p* in the face like a V, very near where the winter solstitial colure crosses the Equinoctial.

DEL-PHI'NUS (*the Dolphin*). *α*, *β*, *γ*, *δ*, in the head, form a diamond called *Job's Coffin*; *ε* in the tail.

LY'RA (*the Harp*). *α*, *ε*, *ζ*, a small equilateral triangle, about as far on one side of the Milky Way as the Dolphin is on the other side.

CYG'NUS (*the Swan*), with outspread wings, flying down the Milky Way. *α*, in the feet, is the top; *β*, in the head, the bottom or foot; *γ*, in the body, the centre; *δ*, in the wing, one side; *ε*, in the other wing, the other side of a large cross, lying along the Milky Way. The *Southern Cross,* and those stars we cannot see in the United States, look for in the circle on the movable horizon.

AU-RI'GA (*the Wagoner*). *α*, *β*, *γ* a triangle; *α*, *β*, *ϑ* a triangle; *ε*, *ζ*, *η*, *Three Kids,* a triangle; *α*, *ϑ*, *ι*, a triangle; four small triangles make one large one, *δ*, *β*, *ϑ* one side, *δ*, *α*, *Three Kids,* and *ι* the other side of the large triangle.

O'RI-ON. *α* in right shoulder, *γ* in left; *λ* in head; *δ*, *ε*, *ζ* in waist, bands, three kings, yard; *η* in knee; *ι*, *c*, *υ* in the sword; *κ* in skirt; *η*, *ι*, *κ* *English Ell*; *β* in left foot; *y*, *σ*, *π*, *q*, *r*, *z* in shield.

LE'PUS (*the Hare*). *α*, *β*, *γ*, *δ* look like a small parallelogram.

CA'NIS MA'JOR (*the Great Dog*). *α* in the nose, the brightest fixed star seen in latitude 40° north; *β*, *ζ* in the fore-paws; *δ*, *ε*, *η*, triangle.

CA'NIS MI'NOR (*the Little Dog*). *α*, *β*.

HY'DRA (*the Water Serpent*). By the painted Planisphere, bring his nose setting in the west, while his tail will not yet be up to the meridian. It is 6½ hours crossing the meridian. Look at any day outside, and see the hour and minute that will be the position of the stars on the sky. When learned, bring any minute to any day desired. The student may easily trace it out: *δ*, *ε*, *ζ*, *η* in the head; *ϑ*, neck; *α*, heart; *κ*, *λ*, *μ*, *ν*. Stars in the *Cup*, *α*, *β*, *δ*, *γ*, *ζ*, *μ*, *η*, *ι*, *ϑ*; then *ξ*, *β*. Next the *CROW*: *α*, *β*, *γ*, *δ* form a large conspicuous trapezium; then *ψ*, *γ*, *u*, *π*. Look them up on the black Planisphere and sky.

CO'MA BE-RE-NI'CES. Stars are all small, reminding us of the Milky Way.

BO-O'TES. *α* in the knee; *η*, *τ*, *υ* foot; *ξ*, *o*, *π*, *ς* in right leg and foot; *ε*, *ρ* waist; *β* head; *γ* left shoulder; *δ* right shoulder. Look them all out on the black Planisphere, a figure 2.

CO-RO'NA (*the Northern Crown*). *ϑ*, *β*, *α*, *γ*, *δ*, *ε* in a semi-circle, or the curve; *δ* in Bootes, the end of the handle of a *Sickle.*

OPH-I-U'CHUS (*the Serpent Bearer*). *α* in the head; *β*, *γ* on the right shoulder. The *Serpent* is beautifully marked out by stars *β*, *γ*, *χ*, *ι*, *ρ*, making an hour-glass, or X, in the head; *δ*, *λ*, *α*, *ε*, *μ*, *δ*, *ε*, *ζ*, *η*, *ν*, *ξ*, *ν*, *η*, *ϑ*.

HER'CU-LES. *α* in head; *β*, *γ* right shoulder; *h*, *n* arm and hand; *δ*, *λ*, *μ*, *ξ* in left arm; *o* in hand; *ς*, *ε* in waist; *u* the star toward which the Sun is said to be moving; *π*, *e*, *ρ* left leg; *η*, *σ*, *τ* right leg; *ι*, *κ* left foot over the head of

DRA'CO (*the Dragon*). *μ* in nose; *β*, *γ* head; *ξ*, *ν* lower jaw. *π*, *τ*, *χ* 2nd coil. *ς*, *η* 3rd coil. *ϑ*, *ι*. *α* 4th coil, *i*, *κ*, *λ*.

THE MOVABLE PLANISPHERE is to Astronomy the same as a Map is to Geography, or to the clear sky what the Directory is to a City. It is the size of a 10-inch Celestial Globe, and as much better as it is cheaper. Of two kinds; one beautifully painted, the other as much like the sky as possible: Stars white on a deep blue-black ground. Both make a complete set. Sold or sent by mail on receipt of $6.

PROBLEMS FOR THE MOVABLE PLANISPHERES.

To determine on any given day when the Star will rise.

RULE 1. Bring the eastern horizon to the centre of the given Star. At the given day, on the circumference of the Planisphere, may be seen on the movable horizon the time when the Star is rising.

When will Reg'u-lus rise Jan. 10th? ans. 8 o'clock, evening.

When will An-ta'res rise May 6th? ans. 4 minutes after 9 o'clock, evening.

When will Al-deb'a-ran rise Sept. 22nd? ans. 9½ o'clock, evening.

To determine on any given day when a Star will set.

RULE 2. Bring the western horizon to the centre of the Star. At the given day, on the circumference of the Planisphere, may be seen on the movable horizon the time when the Star will set.

When will Al-deb'a-ran set on the 27th of April? ans. 9 o'clock, evening.

When will Reg'u-lus set on the 4th of July? ans. 10 minutes before 10 o'clock, evening.

When will An-ta'res set on the 28th of Aug.? ans. 10h. 9m., evening.

To determine on any given day when a Star will arrive at the Meridian.

RULE 3. Bring the graduated Meridian to the centre of the Star. At the given day, on the circumference of the Planisphere, may be seen on the movable horizon the time the Star will arrive at the Meridian.

When will Al-deb'a-ran arrive at the Meridian Feb. 11th? ans. 7 o'clock, evening.

When will Reg'u-lus south on the 17th of March? ans. 20 minutes past 10 o'clock in the evening.

When will An-ta'res come to the Meridian, or south, on the 26th of June? ans. 10 o'clock, evening.

The day of the month, the hour, and minute being given, to find the Stars rising, setting, on the Meridian, or in any other part of the firmament.

RULE 4. Bring the given hour and minute on the circumference of the movable horizon to the given day of the month on the circumference of the Planisphere; hold the Zenith overhead, with South horizon toward the South, North toward the North, East toward the East, West toward the West. On the Planisphere read the names of the Constellations and chief stars, each in its proper position,—the stars rising in the East, those setting in the West horizon; by which simple arrangement can be seen the stars in any part of the sky, at all times sufficiently accurate for most practical purposes.

What Constellations will be on the Meridian Feb. 10th, 8 o'clock, evening? ans. Dove, Hare, Orion, Cam'el-o-pard, Little Bear, and Dragon, and Wagoner in the Zenith.

What important line will be on the Meridian at 10 o'clock, Oct. 21st? ans. the First Meridian, marked out by the four prominent stars, Al'ge-nib, Al'phe-ratz, Caph, and North Polar Star. Find them on the Planispheres.

What star will rise near the northeast at 9 o'clock, evening, October 24th? ans. Cas'tor, in the Twins.

What star will be setting near west-northwest at 10 o'clock, evening, April 11th? ans. Al-deb'a-ran.

When does "A-ri-e'tes south at 10h. 1m. afternoon?" ans. Nov. 20th.

To determine the time of rising or setting of the Sun on any day.

RULE 5. Bring the Eastern horizon, if rising, or the Western horizon, if setting, to the given day of the month marked on the Ecliptic. At the same day on the circumference of the Planisphere is the time, on the circumference of the movable horizon.

What time does the Sun rise, and set, on the 10th of May, in latitude 40° North? ans. Sun rises 8 minutes before 5 o'clock in the morning, and sets 2 minutes after 7 o'clock in the evening.

What time will the Sun rise and set on the 21st of June? ans. rises 4h. 35m., and sets 7h. 32m. What time will the Sun rise and set on the 22nd day of Dec.? ans. rises 7h. 25m., and sets 4h. 29m.

To find the Azimuth and Amplitude of the Sun when rising or setting on any given day.

RULE 6. If rising, bring the Eastern, or if setting, the Western horizon to the given day on the Ecliptic; note the points of the compass, and count on the horizon the degrees to the North or South for the Azimuth, and to the East or West for the Amplitude. At the same day, outside, may be read the minute at which either occurs.

What is the Sun's azimuth and amplitude when rising, or setting, on the 10th of May? ans. azimuth 67°, amplitude 23°.

What is his azimuth and amplitude when rising, or setting, on the 21st of June? ans. azimuth 58°, amplitude 32°.

What is his azimuth and amplitude when rising, or setting, on the 22nd of Dec.? ans. azimuth 58°, amplitude 32°.

ALTITUDE SCALE, by H. M. PARKHURST.

To find the Altitude or Zenith distance of a Star.

RULE 7. Set the horizon for the given day and hour. Lay a straight-edge on the zenith passing through the Star, and cutting the horizon in two opposite points. Observe the point of the compass toward the north, through which the line passes; measuring from the Star to the horizon (or zenith), we have the altitude (or zenith distance respectively) to be taken from the Altitude Scale upon the line from the centre, marked 'Star,' toward the point of the compass already noted.

What is the altitude of Spica June 16th, at 10 o'clock, evening? ans. 31°.

What is the zenith distance of Dubhe at 9 o'clock, May 26th? ans. 32°.

What is the altitude of Deneb at 11 o'clock, evening, April 20th? ans. 15°.

What is the zenith distance of Arctnrus May 29th, at 9 o'clock, evening? ans. 25°.

When or where can Mercury be seen? Only at or near its greatest elongation.

RULE 8. Find in the almanac the gr. Elong. Then find on the Ecliptic, on the Planisphere, the same day (the Sun's place at noon); from that day count the number of degrees on the Ecliptic to the place of Mercury on the Planisphere. East, if evening star; West, if morning star. By Rule 5 see the position at sunrise or sunset. By Rule 7 find its altitude. "May 4th, ☿ gr. Elong. E. 45° 32′" will be 1° in Gemini. "May 20th, ☿ gr. Elong. E. 22° 34′" will be 22° in Taurus 20° high at sunset, seen as evening star.

Among all the stars visible on a clear evening, which is Venus, Jupiter, or any other planet?

RULE 9. Find in the almanac the time the given planet will *rise*, *south*, or *set*, which time also find on the circumference of the movable horizon, and bring it to the same day of the month found on the outer circle of the Planisphere. If *rising*, the place of the planet will be where the Eastern horizon meets the Ecliptic. If *southing*, where the Meridian meets the Ecliptic. If *setting*, where the Western horizon meets the Ecliptic. "May 2d Venus sets 10h. 48m. Aft.," 2° in Gem′in-i. "May 13th, Jupiter rises 7h 18m. Aft.," 26° in Libra.

To find the Moon's place in the Zodiac three times any given day.

RULE 10. Find in the almanac four columns; the Moon rises, or sets, or souths can be found by RULE 9. Moon's constellations in one column, and in the other the degrees. Find on the Planisphere the Ecliptic, and the Constellation, then count in it the given number of degrees for the Moon's place at noon. "May 31st, Moon sets 1h. 8m. Morn.," 26° in Le′o. At noon 29° in ♌ souths 7h. 29m., Afternoon, 2° in Vir′go.

Given in the almanac: Conjunction, or near together, ☌ 0° *apart; Quadrature,* □ 90°; *Trine,* △ 120°; *Opposition,* ☍ 180° *from the Sun* ☉; *to locate either on the Planisphere or sky.*

RULE 11. Find the day of the month on the Ecliptic (Sun's place), from which count the number of degrees to the planet's place, on the Planisphere, then see it in the sky. "May 17th, ☍ ♃ ☉" found 27° in Li′bra. "May 28th, □ ♄ ☉" found 7° in A-qua′ri-us.

When I graduated I could calculate an Almanac, but not name a star on the clear sky; if my Professors knew, they never taught me. Twenty-one years spare time improved, produced my Movable Planisphere. It takes a long time for one to enquire, where do you live? where do you live? and where do you live? to make a directory. When correctly made, how easy to find the one we want? So is this a DIRECTORY OF THE SKY, to Astronomy what a map is to Geography. With them I can teach more on the sky in *one hour* than I learned in *a year* without their use. These explanations are intended to enable the intelligent teacher to do so too. Send Post-Office Order of $6.00 to Henry Whitall, 512 Arch Street, Philadelphia, Pa., and by return mail get a full set.

The first Telescope I bought, which cost my Father $125.00, was so large it was necessary for me to carry out the stand, set it up, then go back, unlock the box and carry the Telescope and put it in place, then go once more for the eye-piece and handles.

I now have a small portable Telescope, I can put into my pocket, stand and all; carry with me to my classes without any inconvenience, that will show me as much and as well as my first one, which I can send by express, C. O. D., for $50.00. With it I can see three stars in the Trapezium of Orion.

A man who shows his Telescope in the streets, and has several sons at the same business, told me he had just sold his large glass for $350.00, cash, that would show four stars in the Trapezium of Orion,—*a great test.*

A noted optician of much repute, asked me to test a Telescope he had sold for $600.00, cash, before it left the store. I met the optician and clerk by appointment; the clerk gave me a part, gave the owner a part, and he shouldered up the largest load for himself to carry to the test place. I saw five stars in the *Trapezium of Orion.* We tried several others; the owner was delighted; he did not ask for a comparison, so I did not intrude my Telescope on him. We carried the Telescope all back, the clerk left with me, and I put my little glass on the same tests, when the clerk said "he would rather have that than the larger one; some had more money than knowledge."

My friend, an Amateur Astronomer, in Wall Street, has a Telescope that, when very favorable and clear weather, will faintly show the sixth star in the Trapezium of Orion. It cost over $1000.00.

For $50.00, I can see three stars; for $350.00, see four stars; for $600.00, see five stars; for $1000.00, see the sixth star faintly. My little Telescope shows me enough for my Astronomy classes easily to understand all the pictures shown by the largest Telescopes.

I showed my Telescope to a celebrated maker to know if I could make a business through him; he told me he would charge $90.00 for making one as good as mine, but would let me have it for $85.00.

The first Telescope I bought cost my Father $75.00 more than I can now sell as good a one for, and cost me many years expense of a horse to haul it around, or two assistants, or for me to go three times to carry my Telescope to the place to show it to my classes of Astronomy, but not see any more than with my $50.00 Pocket Telescope.

Sent by Express, C. O. D. Address, Henry Whitall, 512 Arch Street, Philadelphia, Pa.

"If I could not get another Movable Planisphere, I would not sell mine for *fifty dollars.* GEO. H. CHACE, *Lynn, Mass.*

"Should be in every book-store for sale, and in every family and school for use."—*Telegraph.*

To find the time twilight will begin or end for any given day in the year.

RULE 12. Bring the twilight line to the given day on the Ecliptic; at the same day, outside, read the minute it will begin or end.

When will twilight end Jan. 1st? Ans. 6h. 23m., evening. When Feb. 22nd? Ans. 7h. 14m., evening. When May 20th? Ans. 9h. 8m., evening. When July 4th? Ans. 9h. 32m., evening.

To find the duration of Twilight.

RULE 13. By Rule 5, find the time the Sun will rise or set; by Rule 12, find the time twilight will begin or end. The *duration of twilight* in the morning is from twilight begins to sunrise; and, evening, from sunset to twilight ends.

What is the duration of twilight March 20th? Ans. About 1½ hours. What is the duration of twilight June 21st? Ans. About 2h. 10m.

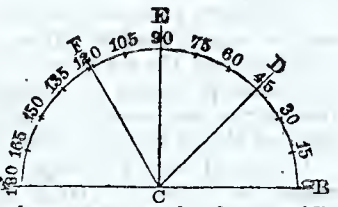
To determine the course and position of the Milky Way at any given time.

RULE 14. Bring the given minute on the circumference of the movable horizon to the given day on the circumference of the Planisphere. The points of the horizon and graduated Meridian over the Milky Way will indicate its course and position.

What is the position of the Milky Way 14m. past 9 o'clock, evening, Jan. 1st? Ans. From S.E., in Zenith, to N.W. What is the course and position of the Milky Way at 10 o'clock, evening, Sept. 6th? Ans. From N.E., in Zenith, to S.W. What is the position of the Milky Way 8h. 21m., evening, Nov. 25th? Ans. From East, in 60° North Declination to West horizon. What is the position of the Milky Way at 10 o'clock, on the 2nd of May? Ans. So near the East, West, and North horizon as not to be seen.

KIDDLE'S ASTRONOMY.

Fig. 7.



Consider B the Vernal Equinox, A the Autumnal Equinox, C the North Pole. B, D, E, F, A, 180° of the Equinoctial; 180° more will complete the circle of 360°. C B will then represent the first meridian, where the right ascension begins. C D, C E, C F, C A, the meridian that may as easily be moved to any other place to mark the right ascension of any heavenly body.

To find the Right Ascension and Declination of a heavenly body.

RULE 15. Bring the meridian to the centre of the star. Where it meets the equinoctial, read the degrees of Right Ascension; at the arrow outside, near March 22nd, read the hours and minutes of Right Ascension. Over the star, on the meridian, read the Declination.

What is the right ascension and declination of β Algol, the variable star in Medusa's head? Ans. 45°, or three hours right ascension, 40° north declination. What is the right ascension and declination of Fomalhaut? Ans. 242¾°, or 22h. 51m. right ascension; declination, 30¼° south.

To find the Declination and Right Ascension of the Sun any day in the year.

RULE 16. Bring the Meridian to the given day on the Ecliptic; over it, on the Meridian, read the Declination. Where the Meridian meets the Equinoctial, read the degrees; and at the arrow by March 22nd, outside, read the hours and minutes of Right Ascension.

What is the right ascension and declination of the Sun March 20th? Ans. 0°. What June 21st? Ans. 90°, or 6h. right ascension, 23° 27′ north declination. What Dec. 21st? Ans. 270°, or 18h. right ascension, 23° 27′ south declination.

Equation of Time.

The Planisphere will illustrate each cause separately, as well as combine both causes, and show the Sun fast or slow for any day. If this were its only use, when rightly understood, all classes of Astronomy would use it when they want to thoroughly understand Equation of Time.

The Equation of Time, when the unequal motion of the Earth only is considered.

RULE 17. Find July on the Ecliptic of the Planisphere, lay a straight piece of paper on July 1st, and make a mark, and another at July 10th, another at July 20th, another at July 31st. Lay first mark at Jan. 1st, on the Ecliptic, make a mark at Jan. 10th, another at Jan. 20th, and another at Jan. 31st. It is remarkable how nearly it will compare with the works on Astronomy having a figure showing that the Radius Vector describes equal areas in equal times.

More accurately by H. M. PARKHURST.

RULE 18. By Rule 16, find the right ascension of the Sun July 1st and 31st. So compare the motion of the Sun in right ascension for July, and see how much farther the Sun moves in Jan.; or so compare any other equal number of days.

To determine the Equation of Time on any given day, the obliquity of the Ecliptic only considered.

RULE 19. Bring the graduated Meridian to the given day on the Ecliptic; the degree, counted from the Vernal Equinox, will indicate the longitude of the Sun. At the same time it will indicate on the Equinoctial his right ascension; the difference of right ascension and longitude is the Equation of Time. If the longitude is greater than right ascension, the Sun is fast, and if it is less, the Sun is slow, four minutes to a degree.

Is the Sun fast or slow on the 21th of May? Ans. 2° difference, or 8 minutes fast. What is the Equation of Time June 21st? Ans. 0. Longitude and right ascension of the Sun agree. What is the equation of time July 31? Ans. 10 minutes slow.

Equation of Time: to find how much the Sun is fast or slow, both causes combined.

RULE 20. Bring the Meridian to the given day on the Ecliptic; at the same day on the outer circle will be the time the Sun is on the Meridian; if before 12 o'clock, the Sun is fast, if after 12 o'clock, the Sun is slow.

Bring the Meridian to Nov. 10th, on the Ecliptic; at that date, outside, will be found 11h. 44m., the Sun being 16 minutes fast.

Is the Sun fast or slow on the 31st of Oct.? Ans. Fast, 16 minutes.

Is the Sun fast or slow on the 24th of Dec.? Ans. Neither. Is the Sun fast or slow on the 31st of Jan.? Ans. Slow, 14 minutes.

To convert Mean Clock Time into Siderial Clock Time.

Rule 21. Bring the given Mean Clock Time on the circumference of the movable horizon to the given day on the circumference of the Planisphere; the minute at the point of the arrow, on the circumference of the movable horizon, will indicate true Siderial Time.

At 33 minutes past 9 o'clock P.M. on the 4th of July, what is the siderial clock time? Ans. 16h. 25½m. At one minute past 11 o'clock P.M., Sept. 18th, what is the siderial clock time? Ans. 22h. 53m. 10s.

To convert Siderial Clock Time into Mean Clock Time.

Rule 22. Bring the Siderial Clock Time to the arrow at March 22, outside; at the day of the month, read the Mean Clock Time on the movable horizon. When the siderial clock is 19h. 44m. 35s., Altair will be on the Meridian; what will be the Mean Clock Time? Ans. Aug. 10th, 10h. 26m. When the siderial clock is 22h. 50m. 37s., Fomalhaut will be on the Meridian, its right ascension: what is the clock time? Ans. 9h. 12m. on the 15th of Oct.

To find the difference between a Siderial and a Solar Day.

Rule 23. Bring the graduated Meridian to any given day on the Ecliptic. From the same day, outside, count the number of minutes to the next day for the difference between a Siderial and a Solar Day.

What is the difference of time between the siderial and solar day Oct. 14th? Ans. Nearly 4 minutes. Try any other day for the same answer.

To find the length of any given day.

Rule 24. Bring the western horizon to the given day on the Ecliptic; the minute on the circumference of the movable horizon, at the same given day on the circumference of the Planisphere, is the time the Sun will set, which time if doubled is the required length of the day.

If greater accuracy is required, add to the time of sunset the equation of time, if the Sun is fast, or subtract it if the Sun is slow, before doubling.

What is the length of the 21st of June? Ans. 15h. 8m. What is the length of Oct. 30th? Ans. The Sun sets at 5h. 0m.; adding 16m.; the equation of time, and then doubling; the day's length is 10h. 32m. What is the length of Feb. 14th? Ans. The Sun sets at 5h. 31m. Subtract 14m., and then doubling, the day's length is 10h. 34m.

To tell the length of a Siderial Day.

Rule 25. Bring the Meridian to the centre of a Star, and note the time. Turn the horizon until the Star sets, and rises, and comes on the Meridian again. Note the time for a Siderial day, the revolution of the Sun upon its axis.

To find the length of a Solar Day, or from the Sun crossing the Meridian any day to crossing it the next day.

Rule 26. Bring the graduated Meridian to the day of the month on the Ecliptic; at the same day, outside, see the time on the circumference of the movable horizon. Then turn the western horizon up to the day of the month, and bring it to the eastern horizon, when it will represent the next morn; and bring the next day to the Meridian, and see at the second day on the movable horizon the time the Sun comes to the Meridian, the time of the Sun's being on the Meridian two successive days.

To find the length of a Lunar Day.

Rule 27. By Rule 10th, locate the Moon on any day. Then bring the Moon's place on the Ecliptic to the Meridian; at the same day, outside, note the time on the circumference of the movable horizon. Bring the Moon setting, and by Rule 10th locate the Moon for the next day, and bring its place onto the Meridian, at which day, outside, on the movable horizon, note the time for a Lunar Day to us.

When the Sun runs highest in Summer, the full Moon runs lowest.

Rule 28. Bring near the N.W. by W. part of the movable horizon to June 21st on the Ecliptic for the Sun setting at his most northern declination. Should the Moon full on that day, she will be seen rising near the S.E. by E. horizon at her greatest southern declination. To make this practical, see in the almanac when the Moon fulls nearest June 21st, and by Rule 10 locate the Moon, and bring the day of the month on the Ecliptic to the western horizon, and see how low the full Moon's place is. Thus June 10, 1873, the Moon fulls; at noon she is 18° in the Scorpion. It will be seen that while the Sun is setting near the N.W. by W., the 18° of Scorpio will be rising near the S.E. by E.

When the Sun runs lowest in Winter, the full Moon runs highest.

Rule 29. Bring the S.W. by W. horizon to Dec. 21st on the Ecliptic for the Sun setting at his greatest southern declination. Should the Moon full on that day, she will be seen rising near the N.E. by E. at her greatest northern declination. Look in the almanac, and see when the Moon fulls nearest Dec. 21st, and by Rule 10 find the Moon's place, then apply this rule.

Dec. 14, 1872, the Moon full, and was at noon 21° in the *Bull*. While the Sun sets near the S.W. by W., see 21° in the *Bull* rising near the N.E. by E.

To find the Azimuth and Amplitude of a Star when rising or setting any given day in latitude 40° North.

Rule 30. Find the given Star on the Planisphere. Bring the eastern horizon, if for rising, or the western horizon, if for setting, to the given Star. Count the number of degrees between the Star and south or north horizon for Azimuth. The degrees between the Star and east or west will be the Amplitude. Read the time it will occur at the day of the month outside.

When will Sirius, the *Dog Star*, rise, set, and what is its azimuth and amplitude when rising or setting? Ans. Rises at 9 o'clock, Nov. 29th, and sets at 9 o'clock, evening, May 1st; azimuth 67½°, amplitude 22½°. When will Arcturus rise and set, and what is its azimuth and amplitude when rising and setting? Ans. Rises 9 o'clock, Feb. 20th, and sets at 9 o'clock, evening, Sept. 24th; azimuth 65°, amplitude 25°.

Wm. Wiley of Detroit, Mich., very acceptably proposes

To obtain the correct Vertical Line for every ten degrees of Azimuth.

Rule 31. The Meridian is a straight line. Ten degrees on either side the *Vertical Line* will be the arc of a circle whose radius is 11.38 inches, which are lay on the Zenith and ten degrees Azimuth, and the space between divide into 90° for *Altitude* or *Zenith Distance*. For 20° Azimuth the radius will be 7.65 inches; for 30°, 6.25 inches; for 40°, 5.55 inches; for 45°, 5.45 inches; for 50°, 5.37 inches; for 60°, 5.25 inches; for 70°, 5.15 inches; for 80°, 5.02 inches; for 90°, *Prime Vertical*, 5 inches,—with the concavity always towards the North.

To tell the minute in the day the Sun will be due East, West, Southeast, or Southwest at any place in or near Latitude 40° North.

Rule 32. Lay the appropriate arc by Rule 31 on 40° North Declination and the desired point of the compass. Turn the horizon until the arc meets the desired day on the Ecliptic. At the same day, outside, read the minute the Sun will be seen in that point of the compass of the horizon.

When will the Sun be due east in New York June 21st? Ans. 8h. 7m., morning. When will the Sun be southeast in New York June 21st? Ans. 10h. 45m., morning. When will the Sun be seen Southwest in Philadelphia Dec. 21st? Ans. 3h. 30m., afternoon.

To find the Azimuth, Amplitude, Zenith Distance, Vertical Circle of the Sun, Moon, Stars, or Planets at any given time.

Rule 33. The Sun's place is where the day of the month is on the Ecliptic. The fixed Stars are marked on the Planisphere. The Planets may be located by the almanac and Problems 8th or 9th. Bring the given time to the day of the month. Lay the proper arc by Rule 31 on the Zenith to pass through the Star, Sun, or Planet's place to meet the Horizon for the *Vertical Arc*. Count the degrees on the Horizon from the North or South to the *Vertical Arc* for the *Azimuth*. From the East or West to the *Vertical Arc* for the *Amplitude*.

Find the Altitude and Zenith Distance by Rule 7.

What is the azimuth, amplitude, zenith distance, and altitude of the Sun at 10 o'clock on the morning of June 21st. Ans. Azimuth, 62°, amplitude 28°, zenith distance 30°, altitude 60°.

To find when the Sun will shine on the North side of a House when he rises or sets, and at noon shine on the South side.

Rule 34. Our position is under the Zenith; the latitude counted on the Meridian whence we look. Should it be at or near 40° North, find on the Ecliptic the day of the month (the Sun's place at noon), and bring it to the East horizon for rising, or West horizon for setting. If North of East or West, the Sun will shine on the North side of the House, or if South, on the South side. Then bring the Meridian to the day of the month on the Ecliptic, when above 24° North latitude, the Sun will be South, and shine on the South side of the House.

To find how long the Sun will shine on the North side of the House on any given day, and how long on the South side.

Rule 35. Lay the Prime Vertical, obtained by Rule 31, on the Zenith and East for after sun-rising, or West for before sun-setting. The Sun will shine on the North side of the House from rising to the Prime Vertical, and shine on the South side until he arrives at the western Prime Vertical, then on the North side until setting.

How long will the Sun shine on the north side, and how long on the south side of a house on Jan. 21st, whose sides are placed to range on the cardinal points? Ans. 3h. 33m. in the morning; shines on the south side 8h. 8m.; and on the north side 3h. 33m. in the evening; 7h. 6m. on north side; 8h. 8m. on south side; the day 15h. 14m. long.

To determine the place of a heavenly body on the Planisphere at any given time, the Right Ascension and Declination being given.

Rule 36. Bring the given time of Right Ascension, found on the outer circumference of the movable horizon, to the arrow, at March 22nd, outside. At the graduated meridian on the Equinoctial will be the degrees of Right Ascension. From that point count the number of degrees of Declination of the object on this Meridian; that number will indicate its place on the Planisphere.

Where is the Sun's place on the Planisphere,—his right ascension, declination, longitude, and latitude being 0? Ans. At the vernal equinox, or first point Pisces (one sign from Aries), where they all begin. Where is the place of Fomalhaut on the Planisphere,—the right ascension being 22h. 50m. 37s., declination 30° 17′ south? Ans. In the eye of the Southern Fish. What is the place of Saturn on the Planisphere on the 4th of July, 1873,—the right ascension being 20h. 11m. 51s., and declination 20° 18′ south? Ans. 30° in the *Archer*.

To convert Degrees of Right Ascension into Time.

Rule 37. Find the given number of degrees of Right Ascension on the Equinoctial. Bring the Graduated Meridian to that number; the arrow by March 22nd, outside, will point to the minute of Time on the circumference of the movable horizon that corresponds to the given number of degrees.

275° are how many hours and minutes of right ascension? Ans. 18h. 20m.

To convert Time into Degrees of Right Ascension.

Rule 38. Bring the given minute of Time on the circumference of the movable horizon to the arrow. The number of degrees of Right Ascension, corresponding to this time, will be found where the Graduated Meridian crosses the Equinoctial.

The right ascension of Al-deb'a-ran is 4h.28m.; what is it in degrees? Ans. 67°. The Right Ascension of Regulus is 10h. 1m.; what is it in degrees? Ans. $150\frac{1}{4}$°. Antares is 16h. 21m. right ascension; what is it in degrees? Ans. $245\frac{1}{4}$°.

To determine the time when a true Meridian Line can be obtained on any given day.

Rule 39. Bring 1h. 12m. afternoon to the arrow; the minute on the circumference of the movable horizon, at the given day on the graduated circumference of the Planisphere, indicates the time when the North Star is in the position to indicate a True Meridian. In six hours from

this time the North Star will be at its greatest western elongation. Six hours later it will be on the Meridian below the Pole. Six hours later it will be at its greatest elongation East.

When can we get a meridian line on the 10th of May? Ans. 2m. before 10 o'clock, evening.

When can we get a meridian line on the 23rd of Nov? Ans. 9h. 1m., evening.

Given the Latitude of the Ship and Day of the Month, to find the Meridian Altitude of the Sun.

RULE 40. Find on the Meridian the degrees of Latitude of the place, and call it *Zenith*. Bring the Meridian to the given day on the Ecliptic. Count the degrees between it and the Zenith for the Zenith distance, which taken from 90° will be the *Meridian Altitude*.

What is the Sun's meridian altitude to-day, Sept. 15th, at noon, in New York? Ans. 52½°.

A ship at sea, 60° south latitude, on Christmas, wants to know the Sun's meridian altitude. Ans. 53½° above north horizon. A ship at sea, 60° north latitude, on Christmas, wants to know the Sun's meridian altitude. Ans. 6½° above south horizon.

Given the Meridian Altitude of the Sun on any day, to find the Latitude of the Ship.

RULE 41. Subtract the Altitude of the Sun, when on the Meridian, from 90° for the *Zenith Distance*. Bring the Meridian to the given day on the Ecliptic, from which count the *Zenith Distance* to the *Latitude of the place*.

The meridian altitude of the Sun July 4th is 72½°: what is the place? Ans. New York, or latitude 40½ north, if seen above the south; or 5½ north latitude, if seen above the north horizon.

A ship at sea measures the meridian altitude of the Sun 30° on Feb. 22nd: what is the ship's latitude? Ans. If above north horizon, the ship is 70° south; if above the south, 50° north latitude.

Given the Latitude of a place in the Torrid Zone, to tell the days the Sun will be Vertical.

RULE 42. Count from 0 over the Equinoctial the given number of degrees to the North or South on the Meridian. Turn the Meridian so that the given number meets the Ecliptic, at which point of meeting read the required day. If the number meets the Ecliptic at two points at each, read the day the Sun is Vertical.

When will the Sun be vertical to all those places that have no altitude, or are on the Equator? Ans. March 20th and Sept. 22nd. When will the Sun be vertical to San José, or all places 10° north latitude? Ans. April 15th and Aug. 27th.

To determine the Latitude and Longitude of a Ship at Sea by a Star visible in the Zenith.

RULE 43. Bring the Graduated Meridian to the Star. If the Star is in the Zenith, its Declination, as found on this Meridian, is the *Latitude* of the Ship. *To determine the Longitude*, we find the Ship's time on the circumference of the movable horizon, at the given day marked on the graduated circumference of the Planisphere. The difference between it and chronometer time, converted into degrees, will give the Ship's Longitude.

If Sir'i-us is in the zenith on the 22nd of Feb., what is the ship's time and latitude? Ans. 8h. 31m., evening, and 16½° south. If An-ta'res is in the zenith on the 4th of July, what is the ship's time and latitude? Ans. 9h. 31m. 45s. P.M. and 26° south latitude.

If Al-deb'a-ran is in the zenith on the 25th day of December, what is the ship's time and latitude? Ans. 10h. 13m. 30s. P.M., and 16½ north latitude.

To find the Latitude and Longitude of a Ship at Sea by any Star on the Meridian, not in the Zenith, but whose zenith distance is determined.

I. *When the Star and Ship are North of the Equinoctial, and the Star North of the Ship.*

RULE 44. Bring the Graduated Meridian to the Star. Find its Declination in degrees, on this Meridian, from which subtract the zenith distance. The remainder is the latitude of the Ship. By Rule 43 find the Ship's longitude.

If the zenith distance of Ca-pel'la on the meridian is 6° on the 25th of Dec., what is the ship's time and latitude? Ans. 10h. 50m., evening, and 40° north latitude. If Al-deb'a-ran is on the meridian, and 6¼° north of the ship on the 25th of Dec., what is the ship's time and latitude? Ans. 10h. 12m. P.M., and 10° north latitude.

II. *When the Star and Ship are South of the Equinoctial, and the Ship South of the Star.*

RULE 45. Bring the Graduated Meridian to the Star. Find its Declination in degrees, on this Meridian, to which add the zenith distance. The sum is the latitude of the Ship. By Rule 43 find the Ship's Longitude.

If Sir'i-us is on the meridian, and 36½° north, on Feb. 22nd, what is the ship's time and latitude? Ans. 8h. 30½m., evening, and 53° south latitude. Spi'ca is on the meridian, and 30½° north of the zenith March 17th: what is the ship's time and latitude? Ans. 1h. 38m., morning, and 41° south latitude.

III. *When the Ship is North and the Star South of the Equinoctial, and vice versa.*

RULE 46. Bring the Graduated Meridian to the Star. Subtract the Declination of the Star from the zenith distance, the remainder will be the Ship's Latitude. By Rulo 43 find the Ship's Longitude.

If An-ta'res is on the meridian, and 66° south of the zenith, on July 4th, what is the ship's time and latitude? Ans. 9h. 31m. 10s. P.M., and 40° north latitude. If Al-deb'a-ran is on the meridian, 76¼ north, on Jan. 1st, what is the ship's time and latitude? Ans. 9h. 48m., and 60° south latitude.

The Latitude of the Ship and the name of the Star given, to find its Meridian Altitude any day in the year, also the time of day.

RULE 47. Count on the Meridian the given degrees of latitude of the place, and call it Zenith. Find on the Planisphere the given star, and bring the Meridian to its centre. Count the degrees between the Star and Zenith for zenith distance. The zenith distance taken from 90° will give the *Meridian* Altitude. At any day outside read the minute of meridian passage of the Star.

A ship at sea, 60° north latitude, sees Arcturus on the meridian, wants to know its altitude and ship's time on June 9th? Ans. Altitude 50°; ship's time, 8h. 58m., evening. A ship at sea, 50½° south, sees Fo'mal-haut on the meridian,

wants to know its altitude and ship's time Oct. 3rd. Ans. 70° above the north horizon; ship's time, 10h. 1m., evening.

To find the Ecliptic North Pole.

RULE 48. Bring 6 o'clock, morning, to the arrow at March 22nd, outside. From the North Pole on the Meridian count 23° 27′ 20″, there stick a pin, and call it the *North Pole of the Ecliptic.*

To make a Graduated Meridian Line.

RULE 49. Slip a clean piece of strong paper under the Meridian to the Pole. Along the graduated side make a mark. Commence 10° from the North Pole, mark all the graduation marks, call each one a degree, make the five-marks a little longer, the ten-marks still a little longer, to within ten degrees of the South horizon, making 120°. Fold the upper marks under, and again slip the paper under the Meridian, so that the line and graduation correspond. Continue to 180°, through it stick a pin, and call it Ecliptic North Pole; leaving a small circle around it, cut the paper on the line; put on the figures to complete the *Graduated Meridian Line.*

To find the Longitude and Latitude of the Sun any day at Mean Noon.

RULE 50. Find the day of the month on the Ecliptic (the Sun's place among the stars). The number of degrees counted on the Ecliptic from March 20th (the Vernal Equinox, or first point Pisces) to the day of the month is the Sun's Longitude in degrees. The Sun has no latitude.

What is the latitude and longitude of the Sun March 20th? Ans 0. What is the latitude and longitude of the Sun Sept. 21st? Ans. Latitude 0, longitude 180°.

The Latitude and Longitude of the Sun, Moon, Planet, Star, or Comet being given, to locate it on the Planisphere or Sky.

RULE 51. Place the Meridian on the Ecliptic Pole by Rule 49. Count on the Ecliptic from the Vernal Equinox the number of degrees of Longitude, to which bring the Meridian. Count the degrees of Latitude on the Meridian from the Ecliptic North or South for the place of the Heavenly Body.

To find the Latitude and Longitude of a Star.

RULE 52. Make a Graduated Meridian Line by Rule 49. Place it upon the Ecliptic North Pole, found by Rule 48. Then bring this Graduated Meridian to the centre of the Star. The Latitude can be counted from the Ecliptic to the Star, while the Longitude can be counted in degrees on the Ecliptic from the Vernal Equinox East to this Meridian Line, passing through the Star and Ecliptic Pole.

Still an easier way to find the Latitude and Longitude of a Star.

RULE 53. Lay a straight piece of paper on the Ecliptic Pole to pass through the Star; at the Ecliptic make a mark; at the Star make another mark; and another at the Pole. Lay the straight piece on the Meridian, and count the degrees between the Ecliptic and Star mark for Latitude, from the Star to the Pole for the Polar Distance. For Longitude count the degrees from the Vernal Equinox East on the Ecliptic to the straight edge.

The Latitude of the place is equal to the Altitude of the Pole.

RULE 54. Count from the Equinoctial the number of degrees the Latitude of the place for Zenith distance, equal to the number of degrees counted from the Pole the North horizon.

To find the Oblique Angle a Star will meet the Horizon in an Oblique Sphere.

RULE 55. Bring the Star to the Horizon, and notice the point of compass of meeting; then bring the Star up to the Meridian, and count its altitude from the South for about the Oblique Angle the Star will make when it meets the Horizon.

To find what Stars are in the Circle of Perpetual Apparition at any place in North Latitude.

RULE 56. Count the number of degrees of Latitude from the Pole. "A radius equal to the altitude of the Pole above the horizon is called the *Circle of Perpetual Apparition.*" — BROCKLESBY. Turn it all around to see what Stars never set.

Will Arc-tu'rus be in the circle of perpetual apparition in New York; if not, where will it be? Ans. No; but in 70° north, on the circle. Which star in the *Dipper* sets in latitude 40° north? Ans. Benetnash, in the end of the handle, not in the circle. Is Deneb, in the top of the *Cross*, in the circle of perpetual apparition in New York? Ans. No, by over 5°.

To find what Stars are in the Circle of Perpetual Occultation any place in North Latitude.

RULE 57. Subtract the Latitude of the place from 90°, and count the number of degrees thus obtained from the Equinoctial for the South horizon; turn it around the Stars, South of that line will be in the Circle of Perpetual Occultation.

Will Fo'mal-haut be seen by a person in 60° north latitude? Ans. No Will An-ta'res be seen? Ans. Yes.

To find the Altitude of a Star as seen from the North Pole.

RULE 58. The Equator will be the horizon at the North Pole. The North Declination of a Star will be its *Altitude.*

What is the altitude of Arc-tu'rus as seen from the North Pole? Ans. 20°.

To find the Altitude of a Star as seen from the South Pole, but visible at 40° North Latitude.

RULE 59. The Equator will be the horizon of the South Pole, and the South Declination will be its altitude read on the Meridian to 50° South.

What is the altitude of Fo'mal-haut as seen from the South Pole. Ans. $30\frac{1}{4}°$.

To find the Altitude of a Star as seen from the South Pole, that is, within the Circle of Perpetual Occultation, in Latitude 40° North.

RULE 60. Run a clean piece of paper under the Meridian, make a mark along it, and mark off 20° of the graduation, which call 40°, the radi of the small circle, pin it to its centre (the South Pole), and then count on it 1° for 2° from the South Pole, which taken from 90° will give *the Altitude.*

What is the altitude of *a* CRUCIS, *Southern Cross*? Ans. South Pole distance, 28°; its altitude, 62°.

To find the Vernal Equinox and First Meridian.

RULE 61. Bring 12 Noon to the arrow, March 22nd. Where the Meridian meets the Equinoc-

tial and Ecliptic, find March 20th, at the Vernal Equinox, the Meridian coinciding with the First Meridian.

To find the Summer Solstice and its Colure.

RULE 62. Bring 6 o'clock, evening, to the arrow, near March 22nd; where the Meridian meets the Ecliptic, find June 21st, at the Summer Solstice, and while the Meridian marks out the Summer Solstitial Colure.

To find the Autumnal Equinox and its Colure.

RULE 63. Bring 12 o'clock, midnight, to the arrow; where the Meridian meets the Ecliptic and Equinoctial, find Sept. 22nd and the Autumnal Equinox, the Meridian coinciding with the Equinoctial Colure.

To find the Winter Solstice and its Colure.

RULE 64. Bring 6 o'clock, morning, or 18h. siderial clock time or Right Ascension, to the arrow; where the Meridian meets the Ecliptic, find Dec. 22nd at the Winter Solstice, while the Meridian marks out the Winter Solstitial Colure.

To find the Stars that shine Vertically over the Torrid Zone.

RULE 65. Count on the Meridian 23° 27′ from the Equinoctial North for the northern, and South for the southern, boundary of the Torrid Zone, all the Stars in that belt shining vertically over the Torrid Zone.

Over what Zone does Reg'u-lus shine? Ans. The Torrid.

To find the Stars that shine vertically over the North Temperate and North Frigid Zones.

RULE 66. Count on the Meridian 23° 27′ from the North Pole, which turn all around for the southern boundary of the North Frigid Zone, and the northern boundary of the North Temperate Zone; the southern boundary of the North Temperate Zone being the North boundary of the Frigid Zone.

Over what Zone does Arc-tu'rus shine. Ans. North Temperate.

To find the Time Twilight will begin and end, and the length of Total Darkness at either Pole.

RULE 67. Twilight begins at the North Pole when the Sun crosses the Equator, Sept. 22nd, and continues to grow darker until he gets 18° below, or South Declination 18°, then total darkness until he arrives to within 18° of the Equator, then twilight begins, growing brighter until he rises, when he arrives at the Equator, March 20th. When he rises at the North Pole, twilight then begins at the South Pole, and continues until he gets 18° North; then comes total darkness until he comes back to 18° North Declination, when twilight will begin at the South Pole, and continue to grow brighter until he rises, when he arrives at the Equator. Count on the Meridian 18° from the Equinoctial, and bring it to meet the Ecliptic in four points: at each point of meeting, read the day of the month the Sun is at that place.

When will twilight begin at the North Pole? Ans. Jan. 28th, when total darkness ends. When will twilight end at the North Pole? Ans. Nov. 13th, when total darkness begins. When will twilight end at the South Pole? Ans. May 11th. When will twilight begin at the South Pole? Ans. Aug. 1st, when total darkness ends.

To find the Harvest Moon.

RULE 68. Find in the almanac the day the Moon fulls in Sept. By Rule 10 locate the Moon for noon that day. Bring the Eastern horizon to the Moon's place. At the same day, ontside, on the movable horizon note the time the Moon will rise. In the same way find the time the Moon will rise for several days. The Moon rising for several evenings so near the retiring Sun, and shining all night, gives the harvester a good opportunity to gather in the fruits of his labor.

To find the Hunters' Moon.—BURRITT.

RULE 69. Find in the almanac the day the Moon fulls in Oct. The same as Rule 68, find the time of the Moon's rising on several days. The Moon for these two fulls will be found to be rising for several evenings about the time the Sun will be setting: thus while the full Moon will be rising in the Eastern horizon, look on the Ecliptic for the day of the month the Sun setting in the Western horizon.

When the difference of time in the Moon's rising is least, the difference of time in setting is greatest.

RULE 70. By Rule 68 find the least difference of the time in the Moon's rising, or Harvest Moon. Bring those several Moon's places to the Western horizon at the same day, outside. Note the difference of time of the Moon's setting to be the greatest.

CHANGING SEASONS. *To find when it will be Summer in any Latitude.*

RULE 71. By Rule 40 find on the Meridian the point to call Zenith. Move the Meridian over the Ecliptic until it comes nearest the Zenith. Count the least Zenith distance at the point of meeting, see the day the Sun will be nearest over head, or *Summer.*

To find when it will be Winter in any Latitude.

RULE 72. By Rule 40 find on the Meridian the point to call Zenith. Move the Meridian along the Ecliptic until it meets the point where it is at the greatest Zenith distance, at which point of meeting see the day the Sun's rays will strike the place most obliquely, or at its greatest Zenith distance, or *Winter.*

To find when it will be Spring or Fall in any Latitude.

RULE 73. Locate the Zenith by Rule 40 for places outside the Torrid Zone by moving the Meridian along the Ecliptic. Find the mean Zenith distance, or those points half way between the greatest and least Zenith distance, which call the Equinoctial points. Note the days of each, the one toward which the Sun approaches call *Spring*, the one from which the Sun receedes call *Fall.*

To find Astronomical and Almanac Spring.

RULE 74. Find on the Ecliptic, March 20th, the Sun crossing the Line, when Astronomical Spring begins; for the beginning of Almanac Spring, look for the first day of March.

To find when Summer begins.

RULE 75. Find on the Ecliptic, June 21st, the Sun at his greatest distance North, longest day, Astronomical Summer begins, but for the accepted first day of Summer, look for June 1st.

To find when Autumn begins.

RULE 76. Find on the Ecliptic, Sept. 22nd, the Sun crossing the Equinoctial, going South, when the Astronomical Autumn begins; but we begin with the month, Sept. 1st.

To find when Winter begins.

RULE 77. Find on the Ecliptic, Dec. 21st, the Sun at his greatest Southern Declination, the shortest day, Astronomical Winter begins; but the Almanac Winter begins Dec. 1st.

To show the Sun rises and sets is false when we see the truth.

RULE 78. Find the Sun's place where the day of the month on the Ecliptic, which the celestial globe makes to rise and set, but on the Planisphere it is at rest while the horizon only moves, which is the truth.

The Stars rise and set is false, taking the Movable Planisphere to be the truth.

RULE 79. Find any Star (which does not move) on the Planisphere. The way to get it to rise or set is to move the horizon to it, East for rising, West for setting. By the celestial globe, the horizon is at rest, and the Stars move the reverse of truth.

The Signs and Constellations of the Zodiac disagree, to find them as taught in the school of to-day.

RULE 80. Look on page 4, find '1. ♈ ♓' Pis'ces (*the Fishes*), so on for all the 12 Signs, as taught in the *school of to-day;* also find them so on the painted Planisphere.

To find the Signs and Constellations agreeing.

RULE 81. Look on the black Planisphere; find the Sign of ♋ Can'cer (*the Crab*) all together; so with all the 12 Signs. Why not have them agree, as they will never come back. So from them agreeing on No. 2, 3, 4, & 5 Planispheres, page 3.

To find the day the Dog-Star will rise with the Sun.

RULE 82. Find *a* Sir'i-us, the *Dog Star*, in Ca'nis Ma'jor's nose, on the painted Planisphere. Then find it on the black one, and bring its centre to near the E.S.E. horizon for rising. Near the E.N.E., where the Ecliptic meets the horizon, see the day the Sun will rise with the Dog Star.

"*If we look directly overhead at* 10 *o'clock on the* 10*th of November.*"—BURRITT, p. 18.

RULE 83. Bring 10 o'clock, evening, to Nov. 10th. In the Zenith find An-drom'e-da, at her feet find her husband, on his knee; on her right her mother; and just behind her find her father, King of Ethiopia,—the *royal family*, not separated on three different maps, which I never could patch together on the sky, but altogether on one map, with all the other Stars and Constellations, each in its proper position in connection with the whole; and move it to any minute at pleasure.

To locate "Teleseopic Objects."—BURRITT.

RULE 84. Bring the hour and minutes of R. A., found on the circumference of the movable horizon, to the arrow at March 22nd, outside, under the Dec., marked on the Meridian, find the place of the 'Telescopic Object.' By Rule 4, find its location on the sky at any time.

R.A., 19h. 24m. 16s.; Dec. N., 27° 37′,—to find the Star. Ans. β Al-bi'reo, in the bottom of the *Cross* and in the *Swan's* head.

To find when the "Acronical rising or setting" (BURRITT) *of a Star will occur.*

RULE 85. Bring the Eastern horizon to the Star for Aeronical rising; where the Western horizon meets the Ecliptic find the day; at the same day, outside, read the hour and minute for Aeronical setting. Bring the Star to the Western horizon, where the Eastern horizon meets the Ecliptic find the day, and at the day outside read the hour and minute it will take place.

To find the Heliacal rising or setting of a Star or Planet.—BURRITT.

RULE 86. Bring the Eastern horizon to the day found on the Ecliptic, and look for the Stars that are Heliacally rising just above the Eastern horizon; or bring the Western horizon to the day of the month on the Ecliptic, for the Stars just above the Western horizon are called Heliacal setting. By Rule 9 locate the Planets.

To find what bright Stars may be looked for, and where to see them at a total Eclipse of the Sun.

RULE 87. Bring the moment of totality, found on the circumference of the movable horizon, to the day of the month, found on the circumference of the Planisphere. Again, find the day of the month on the Ecliptic where the Sun is, and around it see the Stars in their proper positions.

"*To convert the Right Ascension and Declination of a Body into its Longitude and Latitude.*"—NORTON'S ASTRONOMY, p. 70.

RULE 88. Find the Right Ascension and Declination by Rule 15; also find the Latitude and Longitude by Rule 53.

"*Changing Aspect of the Heavens arising from the Rotation of the Earth.*"—BROCKLESBY, 40-45, and 134.

RULE 89. Turn the movable horizon all round, observing on the circumference of the Planisphere the day at the hour and minute on the circumference of the movable horizon of the visible 'starry sky,' instead of repeating what Rev. Prof. Brocklesby has so well said. Read it, and see how well the movable horizon will illustrate the whole mystery.

"*Circumpolar Constellations, and apparent movements of the Celestial Sphere.*"—LOCKYER, 342-344.

RULE 90. Turn the North horizon all around, observing all the Stars and Constellations that never go down, or Circumpolar Stars. Turn the horizon around again, stopping every hour long enough to notice the *Dipper*, to see how remarkably it changes.

"*Constellations visible in the United States on different evenings throughout the year.*—LOCKYER, 143-152.

RULE 91. Bring the given hour and minute, found on the circumference of the movable horizon, to the given day of the month, found on the circumference of the Planisphere. Inside the horizon find the stars visible, each one above the proper point of the compass. When so set, look at any other day; see the hour or minute of the different days throughout the year, the same sky will be seen.

What stars may be seen "Jan. 20th, 10 P.M.;" and at what other times may the stars be seen in the very same place? Ans. Those seen in Fig. 75, Lockyer. See in the Twins three nearly parallel lines crossing three other nearly parallel lines of stars, crossing nearly perpendicularly; also the Three King, pointing out the Hy-a'des and Ple'ia-des on one side, Sir'i-us on the other side. Without changing the Planisphere, see at